APPLICATION FOR PATENT

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Title: Installation of wireless local area network device into a laptop computer

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a wireless local area network device and, in particular, it concerns installation of a wireless local area network device into a laptop computer.

By way of introduction, wireless local area network (WLAN) devices enable laptop computers to establish a local area network and to communicate wirelessly with other computers via the WLAN devices. Each WLAN device has an antenna which is preferably installed in the display cover of the laptop computer so that when the display cover is open, the WLAN antenna is unobstructed, thereby enabling larger wireless coverage.

Of most relevance to the present invention is a prior art system whereby the WLAN device, without the antennas, is installed on the laptop motherboard and the antennas are installed in the display cover. RF cables are routed between the WLAN device on the motherboard and antennas in the display cover. A shortcoming of the aforementioned system is due to the high relative cost of RF cable. A further shortcoming of the aforementioned system is that there is a signal loss in the RF cable of several dB's.

Also of relevance to the present invention is a prior art system whereby the complete WLAN device, including antennas, is installed in the display cover. A USB interface is used to interconnect between the processor on the motherboard and the WLAN in the display cover. Routing of the USB interface cable between the motherboard and the display cover is simple and inexpensive. However, this implementation causes unnecessary power consumption, as the USB host must periodically poll all USB devices, although there may be no data to be received from that device as only a USB host can initiate data transfer.

There is therefore a need for an inexpensive, easy and energy efficient system to install a WLAN device antenna in a display cover of a laptop computer.

SUMMARY OF THE INVENTION

The present invention is a system and method for providing a link between a processor on a motherboard and a WLAN device in a laptop computer.

According to the teachings of the present invention there is provided, a portable computer system, comprising: (a) a display cover; (b) a lower housing; (c) a hinge arrangement configured to mechanically connect the display cover and the lower housing; (d) a processor disposed within the lower housing; (e) a wireless communication device disposed within the display cover, the wireless communication device having an antenna; and (f) an

Ethernet link at least partially defining a communication link between the processor and the wireless communication device.

According to a further feature of the present invention, the wireless communication device is a wireless local area network device.

According to a further feature of the present invention, there is also provided a wired Ethernet port which is operationally connected to the processor, wherein the processor is configured, such that, when the wired Ethernet port is active, the communication link between the processor and the wireless communication device is disconnected.

According to a further feature of the present invention, the Ethernet link is configured to actuate a power save mode of the wireless communication device when the wired Ethernet port is active.

According to a further feature of the present invention, there is also provided a wired Ethernet port which is operationally connected to the processor, wherein the Ethernet link is configured, such that, when the wired Ethernet port is active, the communication link between the processor and the wireless communication device is disconnected.

According to a further feature of the present invention, the Ethernet link includes a switch arrangement which is configured to disconnect the communication link between the processor and the wireless communication device when the wired Ethernet port is active.

According to a further feature of the present invention, the switch arrangement is configured to actuate a power save mode of the wireless communication device when the wired Ethernet port is active.

According to a further feature of the present invention, the switch arrangement includes an Ethernet switch.

According to a further feature of the present invention, the switch arrangement includes at least one analog switch.

According to a further feature of the present invention, the Ethernet link includes an energy detector configured to detect when the wired Ethernet port is active.

According to a further feature of the present invention, the Ethernet link includes a mechanically actuated switch configured to detect when the wired Ethernet port is connected to a wired local area network.

According to the teachings of the present invention there is also provided, a method for communicating between a processor of a computer system and a remote device, the computer system including a display cover, a lower housing, a hinge arrangement, an Ethernet link and a wireless communication device having an antenna, the hinge arrangement being configured to mechanically connect the display cover and the lower housing, the processor being disposed within the lower housing, the wireless communication device being disposed within the display cover, the Ethernet link being configured to at least partially define a communication link between the processor and the wireless communication device, the method comprising

the steps of: (a) operationally connecting the processor and the wireless communication device via the Ethernet link; and (b) communicating between the computer system and the remote device via the wireless communication device.

According to a further feature of the present invention, there is also provided the step of disconnecting the communication link between the processor and the wireless communication device when a wired Ethernet port of the computer system is active.

According to a further feature of the present invention, there is also provided the step of actuating a power save mode of the wireless communication device when a wired Ethernet port of the computer system is active.

According to a further feature of the present invention, there is also provided the step of detecting when a wired Ethernet port of the computer system is active.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is a schematic view of an Ethernet link between a processor and a wireless communication device that is constructed and operable in accordance with a preferred embodiment of the invention;

Fig. 2 is a schematic view of an Ethernet link between a processor and a wireless communication device using a Dual Ethernet PHY that is constructed and operable in accordance with a first alternate embodiment of the invention;

Fig. 3 is a schematic view of an Ethernet link between a processor and a wireless communication device using an Ethernet switch that is constructed and operable in accordance with a second alternate embodiment of the invention;

Fig. 4 is a schematic view of an Ethernet link between a processor and a wireless communication device using an analogue switch and a energy detector that is constructed and operable in accordance with a third alternate embodiment of the invention; and

Fig. 5 is a schematic view of an Ethernet link between a processor and a wireless communication device using an analogue switch and a mechanically actuated switch that is constructed and operable in accordance with a fourth alternate embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a system and method for providing a link between a processor and a wireless communication device in a laptop computer. The principles and operation of a link between a processor and a wireless communication device in a laptop computer according to the present invention may be better understood with reference to the drawings and the accompanying description.

Reference is now made to Fig. 1, which is a schematic view of a portable computer system **8** having an Ethernet link **10** between a processor **22** and a wireless communication device **14** that is constructed and operable in accordance with a preferred embodiment of the invention. Computer system **8** is typically a laptop computer having a lower housing **16**, a display cover **18** and a hinge arrangement **20**, hinge arrangement **20** being configured to mechanically connect lower housing **16** and display cover **18**. Computer system **8** includes processor **22** which is disposed on a motherboard **12** within lower housing **16**. Processor **22** includes the central processing unit and supporting core logic chips of computer system **8**. Wireless communication device **14** is disposed within display cover **18**. Wireless communication device **14** is typically a WLAN device. Wireless communication device **14** has one or more antennas **26**. Ethernet link **10** is configured so as to at least partially define a communication link between processor **22** and wireless communication device **14**. Therefore, operationally connecting processor **22** and wireless communication device **14** via Ethernet link **10** enables computer system **8** to communicate with one or more remote devices via wireless communication device **14**. Part of Ethernet link **10** is disposed within lower housing **16** and part of Ethernet link **10** is disposed within display cover **18**. Ethernet link **10** includes an Ethernet cable **36** which extends from lower housing **16** to display cover **18**. Additionally, other Ethernet devices are needed to form Ethernet link **10**. It will be apparent to those ordinarily skilled in the art

that Ethernet link **10** can be formed using a variety of Ethernet components and devices.

The system of the present invention has the advantage of wireless communication device **14** and antennas **26** being disposed in display cover **18**, so that when the display cover **18** is open, antennas **26** are unobstructed, thereby enabling larger wireless coverage. Additionally, the interconnection between processor **22** and wireless communication device **14** is via Ethernet link **10**. Using the mature and proven Ethernet technology to interconnect between processor **22** and wireless communication device **14** which is disposed in display cover **18**, results in a simple, inexpensive and high performing overall implementation. Moreover, all advanced laptop computers, currently under design or production, include built-in support for both wired (such as IEEE 802.3 Ethernet) and wireless (such as IEEE 802.11 a or b or g) connection to a local area network (LAN). Wired (standard) Ethernet interface **30** is generally connected to a wired LAN port **32** having an RJ45 socket for connection to a wired LAN. The wireless LAN connection is typically provided via an interface (not shown) to a wireless communication device, such as a WLAN device. The laptops are generally configured so that either wired (standard) Ethernet interface **30** or the wireless interface is active at a certain time. Therefore, the Ethernet link **10** of the present invention can be configured to include at least part of existing wired (standard) Ethernet interface **30**, which is located on motherboard **12**. Ethernet link **10** also includes a switching system **34** which routes data from processor **22** either to

wired LAN port **32** when wired LAN port **32** is active, or to wireless communication device **14** when wired LAN port **32** is inactive. Alternate embodiments of switching system **34** are described below with reference to Figs. 2 to 5. Additionally, Ethernet link **10** and/or processor **22** is configured to actuate a power save mode of wireless communication device **14** when wired LAN port **32** is active. This aspect of the invention is described in more detail with reference to Figs. 2 to 5.

Using Ethernet link **10** between processor **22** and wireless communication device **14** has the following advantages: (i) a low number of interconnecting wires, typically 2 analogue pairs; (ii) the length of Ethernet cable **36** does not distort or attenuate the signal, as compared with an RF cable connection; (iii) Ethernet is a well known, commonly used and low cost technology and (iv) wireless communication device **14** is maintained in a power save mode when wired LAN port **32** is active.

Reference is now made to Fig. 2, which is a schematic view of an Ethernet link **38** between a processor **48** and a wireless communication device **42** using a dual Ethernet PHY chip **44** that is constructed and operable in accordance with a first alternate embodiment of the invention. Ethernet link **38** defines a communication link between processor **48** which is installed on a motherboard **40** and wireless communication device **42**. Wireless communication device **42** is typically a WLAN device. Ethernet link **38** includes two analogue pairs **54**, dual Ethernet PHY chip **44** and an Ethernet PHY chip **56**. Dual Ethernet PHY chip **44** is disposed on motherboard **40**. Dual

Ethernet PHY chip **44** is operationally connected to processor **48** via two MII connections **64**. Analogue pairs **54** connect Port2 of dual Ethernet PHY chip **44** to Ethernet PHY chip **56**. Ethernet PHY chip **56** is operationally connected to wireless communication device **42** via an MII connection **58**. A wired Ethernet port **46** is operationally connected to Port1 of dual Ethernet PHY chip **44** using two analogue pairs **60**. Dual Ethernet PHY chip **44** supports the connection between processor **48** and wired Ethernet port **46** as well as the connection between processor **48** and wireless communication device **42**. An example of a suitable dual Ethernet PHY chip **44** is LXT973, which is commercially available for Intel Corporation of 2200 Mission College Blvd., Santa Clara, CA 95052, USA. It will be appreciated by those skilled in the art that dual Ethernet PHY chip **44** may be replaced by two suitable single PHY chips. Either wired Ethernet port **46** or wireless communication device **42** is operational at one time under the control of processor **48** through a MDIO interface **52** of dual Ethernet PHY chip **44**. Processor **48** is configured, typically by software running thereon, to sense when wired Ethernet port **46** is active or inactive. When wired Ethernet port **46** is active, processor **48** actuates dual Ethernet PHY chip **44** to disconnect the communication link between processor **48** and wireless communication device **42** by disconnecting Port2 of dual Ethernet PHY chip **44**. Ethernet PHY chip **56** of Ethernet link **38** is configured to sense the disconnection of Port2 of dual Ethernet PHY chip **44** and thereby force the remaining part of wireless communication device **42** to enter a power save

mode via a GPIO (general purpose in/out) interface **62** of wireless communication device **42**.

Reference is now made to Fig. 3, which is a schematic view of an Ethernet link **66** between a processor **74** and a wireless communication device **70** using a switch arrangement, Ethernet switch **72**, that is constructed and operable in accordance with a second alternate embodiment of the invention. Processor **74** is installed on a motherboard **68**. Ethernet link **66** includes Ethernet switch **72**, an Ethernet PHY chip **76** and two analogue pairs **78**. Ethernet switch **72** is disposed on motherboard **68** and is operationally connected to processor **74** via an MII connection **80**. Analogue pairs **78** connect Port2 of Ethernet switch **72** to Ethernet PHY chip **76**. Ethernet PHY chip **76** is connected to wireless communication device **70** via an MII connection **82**. A digital line **88** connects the LK1 port of Ethernet switch **72** to the GPIO port of wireless communication device **70**. A wired Ethernet port **84** having an RJ45 socket is connected to Port1 of Ethernet switch **72** via two analogue pairs **86**. Ethernet switch **72** supports both the connection between processor **74** and wired Ethernet port **84** as well as the connection between processor **74** and wireless communication device **70**. Ethernet switch **72** works in an unmanaged operation via strapping at system-reset time. When Port1 of Ethernet switch **72** senses that wired Ethernet port **84** is active, Ethernet switch **72** is configured to disconnect the communication link between processor **74** and wireless communication device **70** by disconnecting Port2 of Ethernet switch **72**. Additionally, when Port1 of Ethernet switch **72** senses that

wired Ethernet port **84** is active, Ethernet switch **72** deactivates wireless communication device **70**, actuating a power save mode of wireless communication device **70**, by sending a signal from the LK1 port of Ethernet switch **72** to the GPIO port of Wireless communication device **70**. Wireless communication device **70** remains in power save mode until Port1 of Ethernet switch **72** no longer senses activity from wired Ethernet port **84**. Upon activation of Port2, a signal from the LK1 of Ethernet switch **72** is used to awaken wireless communication device **70**. An example of a suitable Ethernet switch **72** is KS8993, which is commercially available from Kendin Communications, Inc. of 486 Mercury Drive, Sunnyvale, CA 94086, USA.

Reference is now made to Fig. 4, which is a schematic view of an Ethernet link **90** between a processor **91** and a wireless communication device **94** having a switch arrangement, the switch arrangement including two analogue switches **96**, **98** and an energy detector **100** that is constructed and operable in accordance with a third alternate embodiment of the invention. Processor **91** is installed on a motherboard **92**. Ethernet link **90** includes a standard single Ethernet PHY chip **102** which is connected to processor **91**. Ethernet link **90** also includes a standard Ethernet PHY chip **104** which is connected to wireless communication device **94**. The TX port of Ethernet PHY chip **102** is connected to analogue switch **96** via an analogue pair **106**. The RX port of Ethernet PHY chip **102** is connected to analogue switch **98** via an analogue pair **108**. The TX port of Ethernet PHY chip **104** is connected to analogue switch **98** via an analogue pair **110**. The RX port of Ethernet PHY

chip **104** is connected to analogue switch **96** via an analogue pair **112**. The TX connection of a wired Ethernet port **114** is connected to analogue switch **96** via an analogue pair **116**. The RX connection of wired Ethernet port **114** is connected to analogue switch **98** via an analogue pair **118**. Analogue switch **96** is either implemented as two switches or a single differential switch. Analogue switch **96** is configured to route the TX signal from Ethernet PHY chip **102** to either Ethernet PHY chip **104** or wired Ethernet port **114**. Similarly, analogue switch **98** is configured to route the RX signal from wired Ethernet port **114** to Ethernet PHY chip **102** or the TX signal from Ethernet PHY chip **104** to Ethernet PHY chip **102**. Analogue switch **96** and analogue switch **98** are controlled by energy detector **100**, which senses when wired Ethernet port **114** is active. When energy detector **100** senses the existence of an active RX signal of wired Ethernet port **114**, energy detector **100** provides a control signal to analogue switch **96** and analogue switch **98** via a control line **115** thereby connecting Ethernet PHY chip **102** to Ethernet PHY chip **104**. Typically, Ethernet PHY chip **104** is configured to sense the disconnection of Ethernet PHY chip **104** from Ethernet PHY chip **102** and thereby force the wireless communication device **94** to enter a power save mode via a GPIO interface of wireless communication device **94**. Alternatively, wireless communication device **94** is forced into a power save mode by energy detector **100** sending a signal to a GPIO port of wireless communication device **94** via one or two digital control lines **120**.

Reference is now made to Fig. 5, which is a schematic view of an Ethernet link **122** between a processor **125** and a wireless communication device **126** using a switch arrangement, the switch arrangement including two analogue switches **128** and a mechanically actuated switch **130** that is constructed and operable in accordance with a fourth alternate embodiment of the invention. The switch arrangement establishes either a connection between processor **125** and wireless communication device **126** or a connection between processor **125** and a wired Ethernet port **132** having an RJ45 socket. The embodiment described with reference to Fig.5 is substantially the same as the embodiment described with reference to Fig. 4 except that energy detector **100** of Fig. 4 is replaced by mechanically actuated switch **130**. Mechanically actuated switch **130** is configured to detect when the RJ45 socket of wired Ethernet port **132** is connected to a wired local area network via an RJ45 plug (not shown). When the RJ45 plug is inserted into the RJ45 socket of wired Ethernet port **132**, the RJ45 plug actuates mechanically actuated switch **130**. When the RJ45 plug is connected to wired Ethernet port **132**, a logic level "0" is held on a control line **136**, such that, wireless communication device **126** is disconnected from processor **125** and wired Ethernet port **132** is connected to processor **125**. When the RJ45 plug is removed from the RJ45 socket of wired Ethernet port **132**, mechanically actuated switch **130** is released and a pull-up resistor **134** provides a logic level "1" on control line **136**, such that, wireless communication device **126** is connected to processor **125** and wired Ethernet port **132** is disconnected from processor **125**.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and sub-combinations of the various features described hereinabove, as well as variations and modifications thereof that are not in the prior art which would occur to persons skilled in the art upon reading the foregoing description.